THE WEATHER AND CIRCULATION OF MARCH 1961[1]

Another Mild Month in the United States

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1. HIGHLIGHTS

The mild weather of the second half of February 1961 [1] persisted into March as temperatures averaged above seasonal normals in nearly the entire United States (fig. 1). A notable exception was Alaska, where near record cold prevailed. Frequent storminess in the central Plains, associated with a mean trough (fig. 2), brought heavy precipitation and flooding to much of that area. This March was in sharp contrast to March of 1960 [2], a very cold, snowy period in the eastern two-thirds of the Nation.

2. AVERAGE CIRCULATION

The monthly mean circulation patterns at 700 mb. (fig. 2) and sea level (fig. 3) for March 1961 were featured by strong blocking in the Atlantic. This was associated with a band of positive anomaly of both 700-mb. height and sea level pressure around 55° N., and a much deeper than normal trough near mid-Atlantic. In addition, the Icelandic Low was split and displaced southward, a feature commonly associated with blocking.

Blocking was also present over North America, where 700-mb. heights averaged as much as 160 feet above normal over James Bay (fig. 2). A deeper than normal trough extended from mid-United States southwestward. The rather short wave spacing that existed at middle and low latitudes across North America and the Atlantic was quite characteristic of blocking.

Blocking also appeared in the Pacific, where it was related to the center of positive height anomaly near Kamchatka, the deep trough in the Gulf of Alaska at 700 mb. (fig. 2), and the southward displacement of the split Aleutian Low at sea level (fig. 3).

The circulation in polar regions was dominated by a strong High centered north of Alaska at sea level and aloft (figs. 2 and 3). This cell developed strongly near mid-month, concomitant with appearance of a deep cyclonic center in northern Scandinavia. Both cells remained quasi-stationary, reaching their greatest strength during the 5-day period March 23–27 when the maximum mean sea level pressure in the High was 1047 mb. and the minimum in the Low 982 mb.

Over Eurasia the mean circulation was well defined, consisting of a deep trough in eastern Europe flanked by strong ridges, and there was little displacement of these features from sea level (fig. 3) to 700 mb. (fig. 2). The European ridge-trough system was associated with the strongest height anomalies in the Northern Hemisphere (+390 ft. and −470 ft. in fig. 2).

The monthly mean isotach chart and its departure from normal (fig. 4) further reflect the blocking character of the circulation at 700 mb. The jet axis at this level was well defined and displaced south of its normal position over nearly the entire western portion of the Northern Hemisphere. Note also the unusual double jet across the Atlantic. These two jet axes merged in the northeastern Atlantic to produce an extensive area of above normal wind speeds, as much as 11 m.p.s. above normal over southern Scandinavia (fig. 4B).

Wind speeds well above normal were also observed in the eastern Pacific (fig. 4B). As this strong current approached the west coast of the United States, it underwent marked diffluence, aided in part by blocking in Canada.

3. CIRCULATION TRANSITION WITHIN THE MONTH

The most important change in circulation during the month was associated with retrogression of a pronounced blocking wave which developed from a strong ridge over

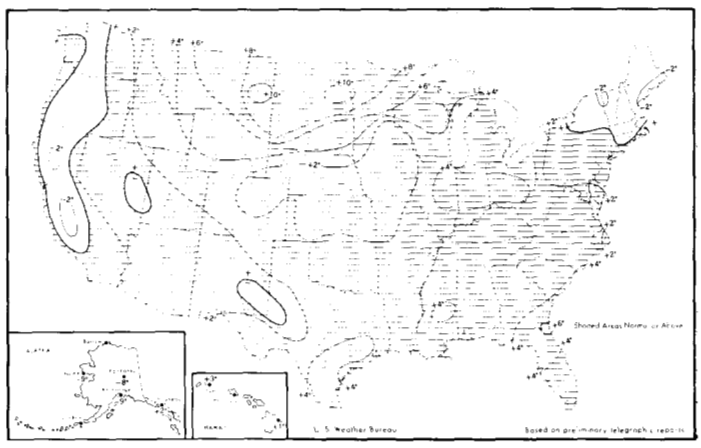

FIGURE 1.—Departure of average temperature from normal (° F.) for March 1961 (from [5]). Mild weather dominated the Nation.

[1] Descriptions of the weather of April, May, and June 1961 will appear in the July, August, and September issues of the *Monthly Weather Review*, respectively.

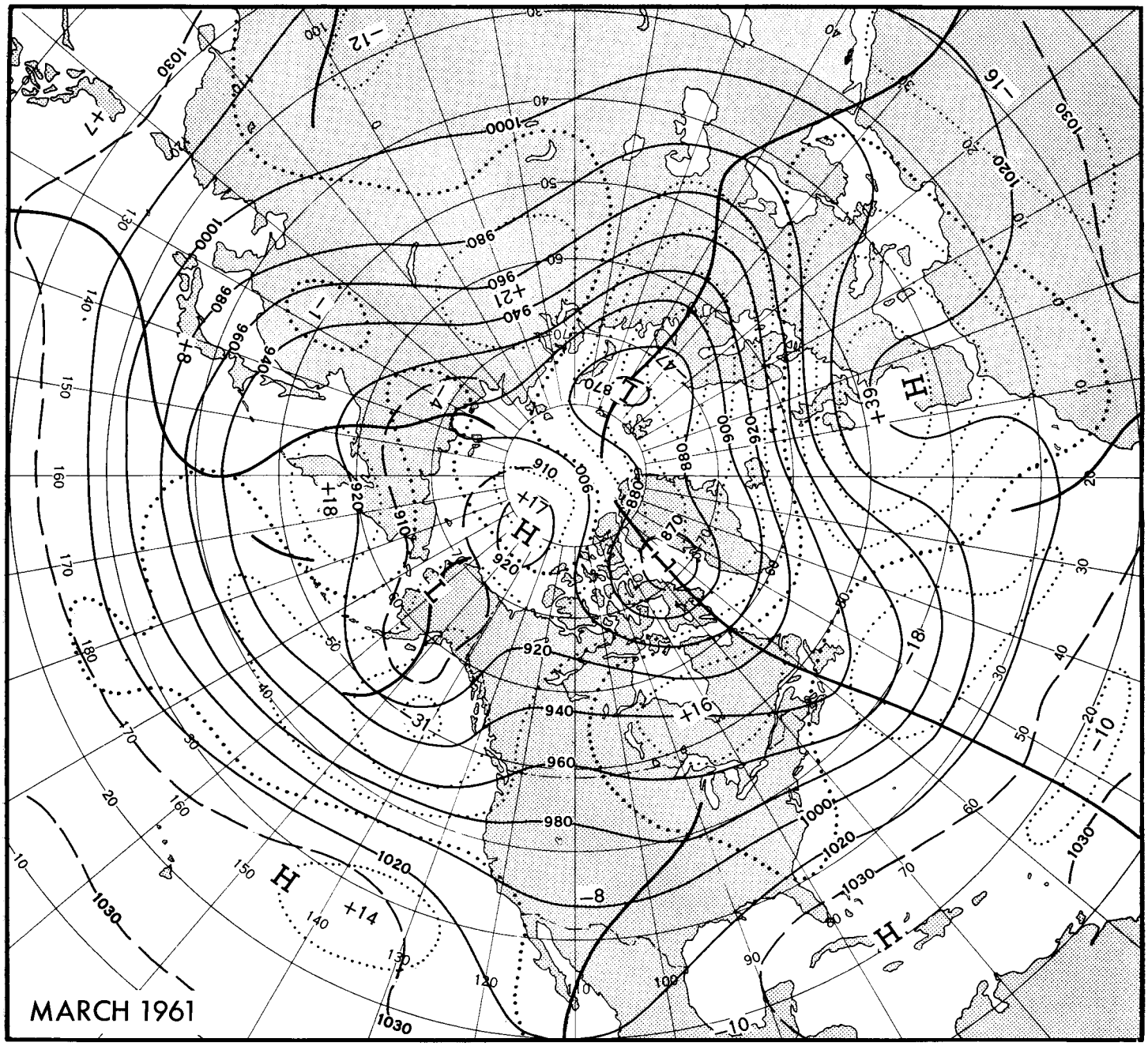

FIGURE 2.—Mean 700-mb. contours (solid) and departures from normal (dotted), both in tens of feet, for March 1961. Blocking at middle latitudes was prominent over North America and the Atlantic.

Europe in February [1]. During March the blocking spread across the Atlantic into North America, accompanied by an abrupt transition from high to low zonal index conditions (fig. 5). The magnitude of this transition in circulation is shown in figure 6, which gives the change in 700-mb. height between the first and last halves of the month. Note the pronounced increase in heights at higher latitudes and falls at lower latitudes over the Atlantic and North America. The greatest change occurred in the Atlantic where 700-mb. heights rose as much as 740 feet.

A further manifestation of this reversal in circulation is obtained by comparing typical 5-day mean patterns of 700-mb. height and sea level pressure observed at time of high index (fig. 7) and low index (fig. 8). Of additional interest are the tracks of primary, migratory cyclones (dashed) and anticyclones (dotted) appearing during these 5-day periods and superimposed on the sea level charts. The high-index patterns (fig. 7) display most of the characteristic features of this type of circulation [3]; i.e., fast zonal westerlies, small wave amplitude aloft, and pressure systems oriented east-west.

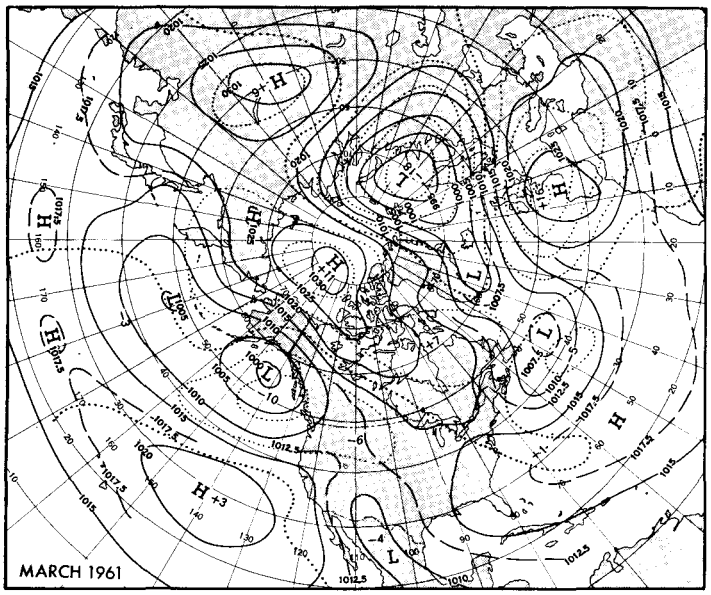

FIGURE 3.—Mean sea level isobars (solid, with intermediate isobars dashed) and departures from normal (dotted), both in millibars, for March 1961. Unusually strong pressure gradients prevailed across Europe and Alaska.

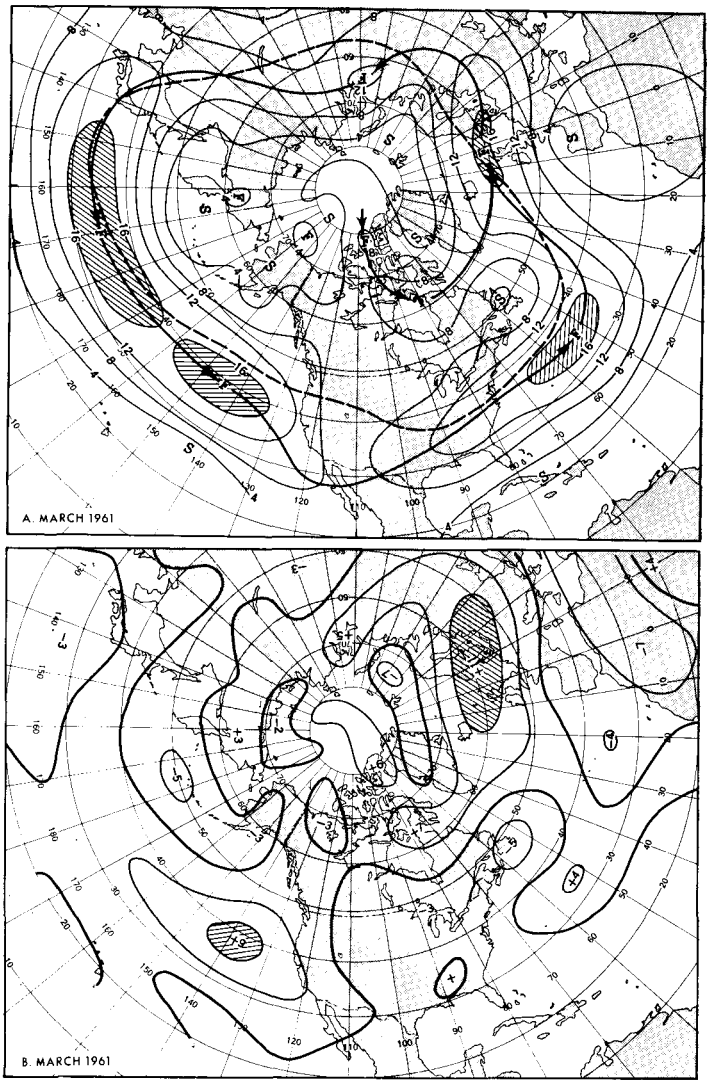

FIGURE 4.—(A) Mean 700-mb. isotachs and (B) departures from monthly normal wind speeds, both in meters per second, for March 1961. Solid arrows in (A) indicate principal axes of maximum wind speeds, and dashed arrows their normal March positions. Regions with wind speeds greater than 16 m.p.s. and anomalies greater than 8 m.p.s. are hatched. The westerlies were south of their normal position over much of the hemisphere.

During the period of lowest index the circulation was characterized by a disruption of the westerlies into closed cellular centers, shorter wavelengths aloft, and a general north-south orientation of pressure systems (fig. 8). In addition, the split storm track in the Atlantic during low index contrasts with the single primary track across the Atlantic during high index. Note also (fig. 8B) the high frequency of slow-moving storm centers in the central United States with low-index conditions. Strong blocking in the Atlantic was evidenced by development of an upper-level "omega" pattern (fig. 8A). Retrogression of blocking into North America was accompanied by development of a similar "omega" pattern in the United States, although not as pronounced as in the Atlantic.

An additional comparison of these extreme circulation states can be made by reference to figure 9, which shows the 700-mb. zonal wind speed profiles for the two periods. The sharply peaked profile associated with high index is in marked contrast to the double peaked profile and displaced westerlies with low index.

4. WEATHER IN THE UNITED STATES

TEMPERATURE

Temperatures in the United States during March 1961 averaged warmer than normal over all but the extreme Northeast, the interior valleys of the Pacific Coast States, and Alaska (fig. 1). Greatest positive departures were observed in the Northern Plains and Upper Mississippi Valley—as much as +10° F. in the eastern portions of Montana and North Dakota. Persistence of the temperature pattern, usually considered in terms of the total zero-plus-one-class change [4], was extremely high from February to March, as 93 percent of the country did not change by more than one class (out of five). This compares with an average of 68 percent for the period 1942–60.

The mild temperature regime was quite well related to the mean circulation patterns. At 700 mb. the anomalous flow between the east coast ridge and the southwestern trough was predominantly southeasterly over all but the Far Southwest and Northeast, where northerly flow was associated with cooler conditions (fig. 2). Moreover, strong Pacific westerlies (fig. 4) combined with a deep trough in the Gulf of Alaska and southerly anomalous flow in western Canada (fig. 2) to result in relatively mild Pacific air masses throughout most of the Nation. The thickness in the layer from 1000 to 700 mb. also corresponded well with the temperature pattern (figs. 1, 10).

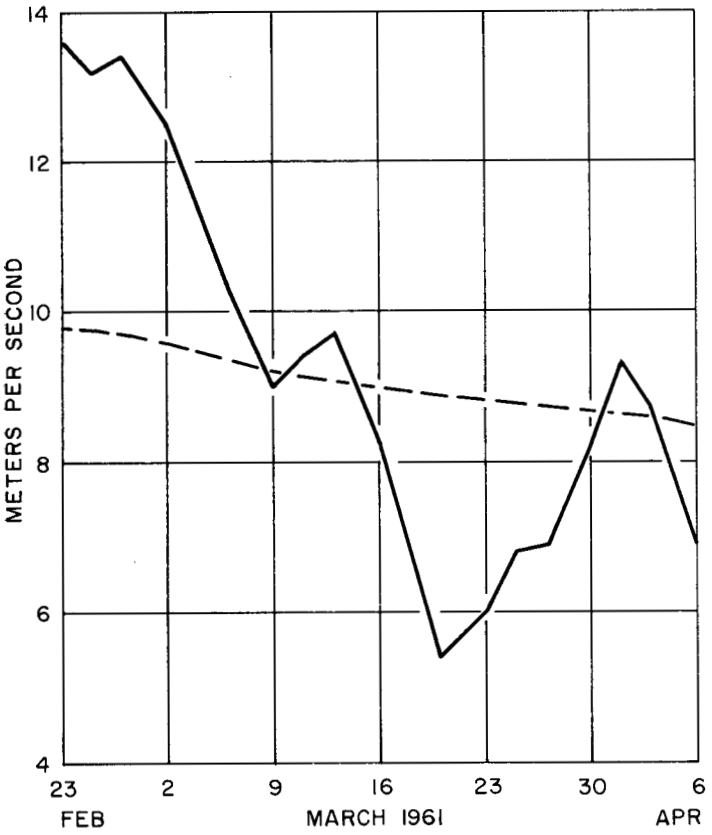

FIGURE 5.—Time variation of speed of 700-mb. westerlies averaged over the western half of the Northern Hemisphere between latitudes 35° and 55° N. Solid line connects 5-day mean zonal index values (plotted at middle of period and computed thrice weekly), while dashed line gives the corresponding "normal" averaged from maps of [6]. Note pronounced index cycle during March.

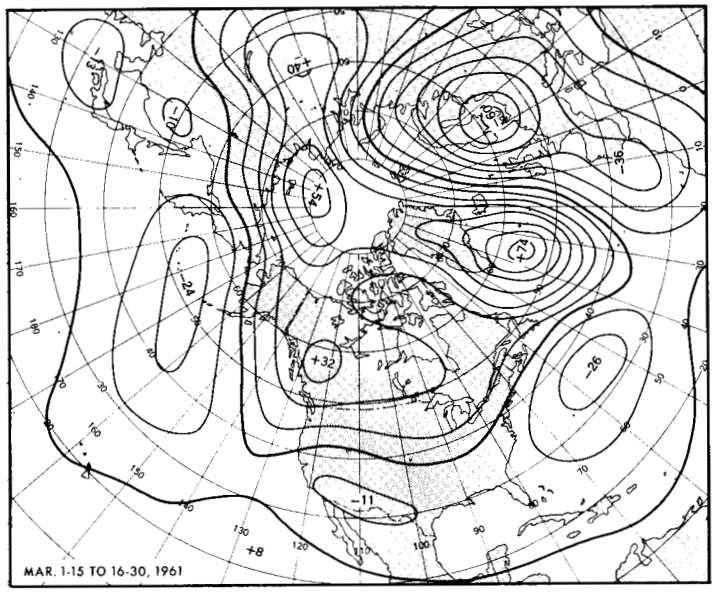

FIGURE 6.—Change of mean 700-mb. height (tens of feet) from first to second half of March 1961. Height rises at higher latitudes and falls at lower latitudes over the Atlantic and North America reflect retrogression of blocking.

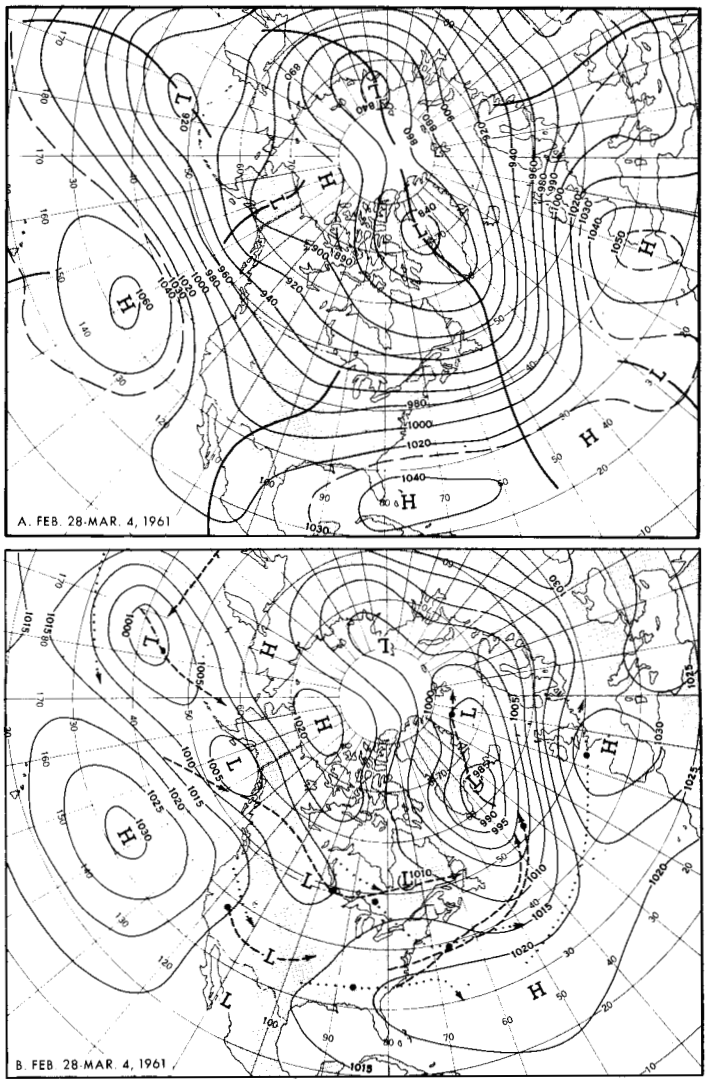

FIGURE 7.—Five-day mean charts for February 28–March 4, 1961 for (A) 700-mb. contours (tens of feet) and (B) sea level isobars (millibars). Tracks of important migratory cyclones (dashed) and anticyclones (dotted), with March 2 positions indicated by large dots, are shown on (B). These circulation patterns were associated with high-index conditions early in the month.

A good example of the effect of cloudiness and precipitation on the temperature pattern was observed during March in the Plains States. This is seen by comparing figures 1 and 11. Unusually dry conditions and abundant sunshine were related to the large positive temperature departures in the Northern Plains, while to the south heavy precipitation, much of which was in the form of frequent snows, was associated with temperatures close to normal.

The most unusual warmth occurred during the period March 4 to 6 in the eastern half of the Nation, when early-season maximum temperature records were either established or equaled at Peoria, Ill., Augusta, Ga., Wilmington, N.C., and Richmond, Va. This warmth occurred when the mean ridge over the east coast (fig. 2) reached its greatest strength.

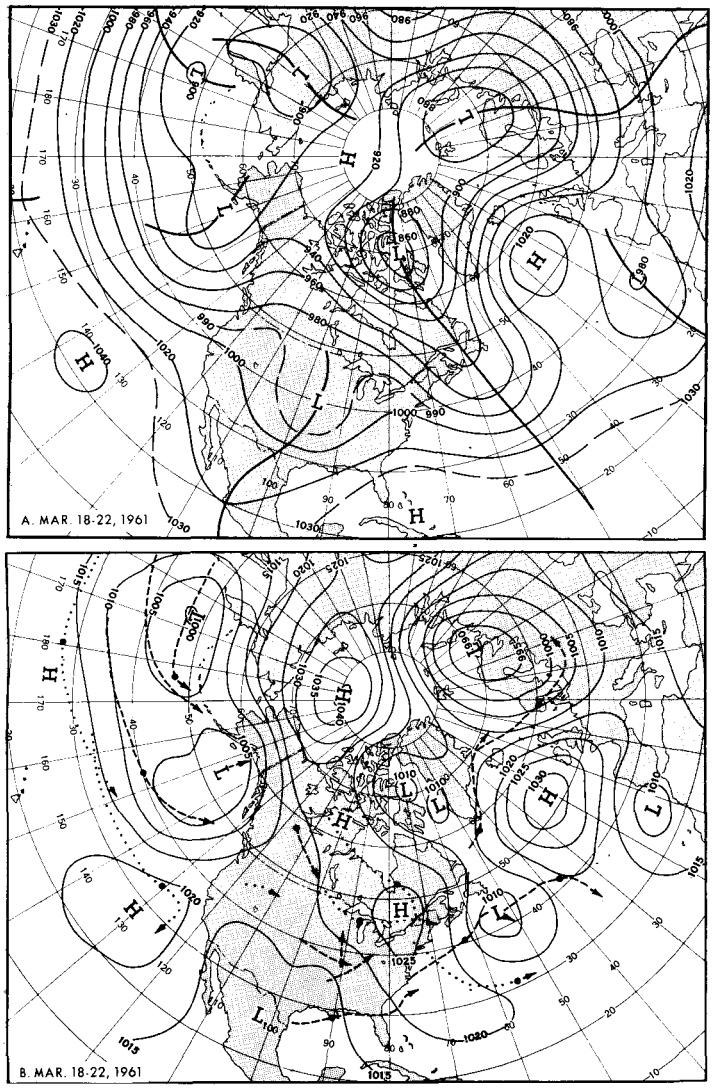

FIGURE 8.—Five-day mean charts, (A) 700 mb. and (B) sea level, for the period March 18–22, 1961, with March 20 positions of cyclones and anticyclones shown by large dots. These circulation patterns were characteristic of low-index conditions late in the month.

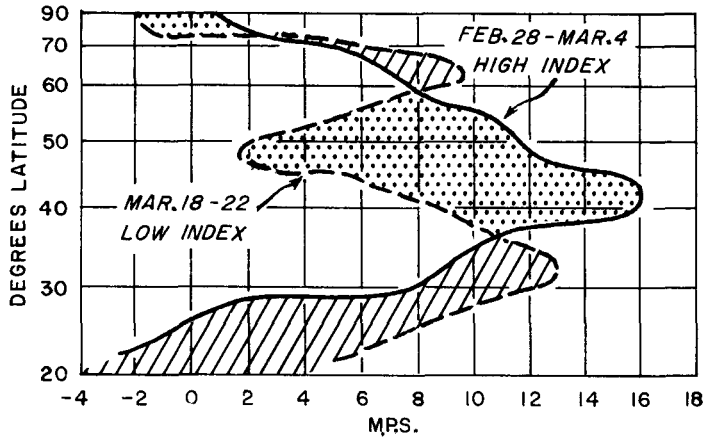

FIGURE 9.—Five-day mean wind speed profiles for high- and low-index stages of the index cycle during March 1961. Decrease in speed of the westerlies at middle latitudes was compensated for by an increase at lower latitudes, thereby tending to conserve the total westerly momentum.

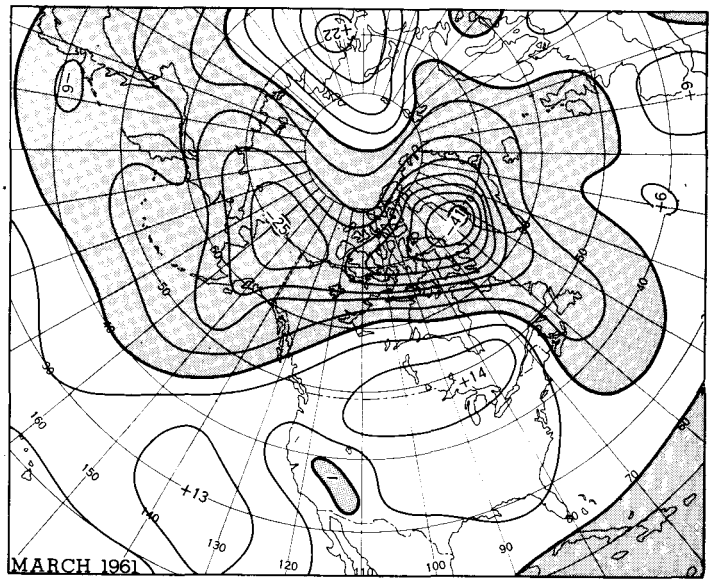

FIGURE 10.—Mean 1,000–700 mb. thickness departures from normal (tens of feet) for March 1961, with areas of subnormal values shaded. Abnormally cold air covered the higher latitudes of North America, but warm conditions were dominant elsewhere over the continent.

Near the end of the month retrogression of blocking into Canada, along with below normal upper-level heights in most of the United States, was accompanied by a gradual change from a warm to a cold regime.

While the contiguous United States had mild weather, Alaska experienced an unusually cold March in all but the southeastern coastal area (fig. 1). A partial explanation for this extreme cold lies in the stronger than normal northeasterly flow from the Arctic Basin at sea level (fig. 3), along with below normal 700-mb. heights (fig. 2). In addition, the thickness in the layer from 1000 to 700 mb. (fig. 10) was well below normal. Note also the unusual extent of the area of cold thickness at higher latitudes, with a center of extreme cold over the Davis Strait and a strong gradient to the south.

PRECIPITATION

Precipitation over much of the Nation was adequate during March, and more than twice the normal amount fell in portions of the Pacific Northwest and the Central Plains (fig. 11). At Yakima, Wash., this was the second wettest March of record, precipitation being more than four times the normal. Near record amounts also fell elsewhere in Washington and Oregon. This heavy precipitation was related to frequent storms moving eastward from the Pacific in faster than normal southwesterly flow (figs. 2, 3, 4).

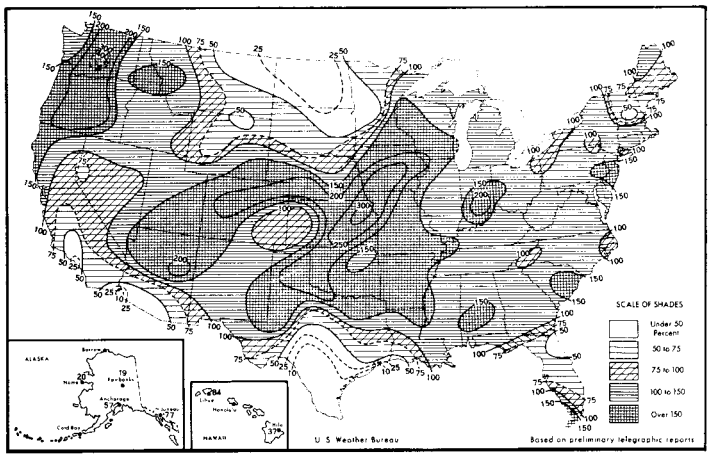

FIGURE 11.—Percentage of normal precipitation for March 1961 (from [5]). Near record amounts of precipitation fell in the Central Plains and Pacific Northwest.

Heavy amounts also fell in the middle of the Nation where Des Moines, Iowa and Kansas City, Mo. both reported record precipitation totals for any March. This resulted in considerable flooding in Iowa and portions of Minnesota and Wisconsin. Record high river stages were reached late in the month along the Cedar River in Iowa at Charles City and Waterloo. This heavy precipitation was associated with the deep mean trough in the Southwest and related storm systems which moved from the southern Plateau to the Great Lakes region.

Unusually dry conditions prevailed in the Northern Plains (fig. 11), where near record dryness was observed in North Dakota. This area lay between two primary storm tracks, one to the south and the other across southern Canada. Ridge conditions and northwesterly flow aloft (fig. 2) also were related to the dryness.

Precipitation was also well below normal in southern portions of California, Arizona, and Texas (fig. 11). At Prescott, Ariz., the period from November 1960 to March 24, 1961 was the driest such period on record since 1865. Near the end of the month, however, a record 24-hour snowfall of 9 inches broke the long dry spell. The dryness in California and Arizona was related to stronger than normal northerly flow in the rear of the mean trough (fig. 2). The precipitation deficit in southern Texas is more difficult to relate to the mean circulation patterns at sea level (fig. 3) and 700 mb. (fig. 2). However, a possible explanation lies in the position of the 700-mb. mean jet maximum through central Texas (fig. 4A), with relatively heavy amounts of precipitation observed north of the jet and light amounts in subsidence and anticyclonic vorticity to its south.

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